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planting it, I believe, with great accuracy in the meridian. On returning home I found the × intersected by the middle wire, but it did not appear to be perfectly bisected by it; the atmosphere was, however, rather disturbed at the time.

"A day or two after, the × appeared to me to be perfectly bisected by the middle wire; and as I have reason to believe the instrument was at that time very nearly in the meridian, I considered the position of the south point sufficiently determined.

"From observations on April 25th, on *α Urs. Maj.* and *δ Hyd. et Crat.*, I calculated the azimuthal error to be $+0''\cdot12$; and on April 29th the mean of the two results obtained from *β^1 Scorpii* and *ξ Urs. Min.* with illumined axis east, and *α Ophiuchi* and *ε Urs. Min.* with illumined axis west, was $-0''\cdot36$.

"So small an arc as either of these, when measured along the horizon, being quite an invisible quantity with the ordinary power of the telescope, I thought there was no use in trying to bring the instrument any nearer to the meridian.

"The only point of interest that remained was to measure the interval along the horizon which corresponded to the interval between two wires, that, knowing the space corresponding to a given arc, I might form an idea of the accuracy of the results which the meridian mark will afford, at the same time that I could calculate the distance from it to the observatory.

"The interval between two of the wires, measured on the ground, was 39 feet, and the equatoreal interval for the same wires $= 24^{s}\cdot34 = 6'\ 11''\cdot10$. This gives 4·13 miles as the distance of the mark from the observatory.

"The northern point was found in the same manner as the south, by expeditions made on April 21st, May 1st, 8th, and 22d, and is marked by a heavy larch-pole, 14 feet in length, and sunk 4 feet deep into the ground. On the top is a cross similar to that used in the south, with this difference, that the bars are 3 feet instead of 2 in length. The distance between two wires, measured along the north horizon, was 45·3 feet, which gives 4·8 miles as the distance from the observatory."

1851, April 10, Mr. Weld observed the occultation of a small star by the dark limb of the moon, at $12^{h}\ 36^{m}\ 59^{s}\cdot7$ Stonyhurst sidereal time. H.C. 18007.

On some Improvements in Reflecting Instruments.

By Prof. Piazzi Smyth.

In the course of his lectures on Practical Astronomy to the students of the Edinburgh University last winter, Prof. P. Smyth had unusual opportunity of ascertaining those points in the making of the generality of the observations of navigators by sea and of travellers on land, which presented the greatest difficulty to beginners. And as these points generally consisted of needless peculiarities, sometimes absolute imperfections in the instruments, the Professor proceeded to remove them as well as he could, and

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the result may, perhaps, be more extensively useful, especially as the difficulties were generally felt on the sextant being applied to observations of *stars by night*, a more exact means than the sun by day, and therefore to be encouraged and assisted in every way.

In naval observations the impediments were, both by the experience of the class, and by the testimony of naval officers,

1st. Difficulty of seeing and of bringing down the star.

2d. Difficulty of seeing the horizon line at night.

3d. Difficulty of reading off the angle on the limb.

The first of these, in so far as it depended on the dark field of the telescope, he proposed to remedy by employing a telescope of large aperture, say 2 inches, in place of the usual size, ½ or ¾ inch; in so far as the loss of light was occasioned by reflexion and absorption at the glasses, he intended to remove this by employing *metal* reflectors, by which, too, the occasional nuisance of *second* images would be avoided and greater accuracy obtained. He had tried speculum metal for the purpose with great advantage; but, under some circumstances, he was in hopes of being able to employ silver, which has lately been found to be capable of reflecting near double the amount of light that speculum metal does, though that retains more than quicksilvered glass; and then, in so far as the loss of the star in "bringing down" is caused by the diminished surface exposed by the index-glass at large angles, he proposed to make that larger than usual: besides which, the reflexion taking place in the metal at the first surface, there would be no loss, as now, from the thickness of the edges of the glass or the sides of the brass box containing it.

The second difficulty would be alleviated by the same adoption of the large object-glass: besides the loss of light by transmission through the so-called transparent part of the present horizon-glass would be done away with by the employment of the metal reflectors.

The third difficulty was also shown to be gratuitous, for the reflector of the reading-glass was in general so placed that the light of the lamp could not get to it, and if it did, would be thrown away from the arc instead of on it: and were even that managed, the surface of the vernier and arc being in different planes, the same ray of light would not illumine them *both* at the *same* time. By placing them, however, both in the same plane, and by putting the reflector at an angle of 45° to the limb, instead of parallel to it, so as to receive parallel light and throw it straight down to the divisions, it was found that they could easily be read by a very faint light.

For accuracy, opposite readings were deemed essential, and a circle insisted on in place of a sextant or quadrant; and the author, considering that the failure of the reflecting circle in securing a permanent footing in the navy arose from its being made in general too large and heavy, and complicated, he had devised a very small, but strong and simple form; the telescope was more firmly connected by moving in grooves on the large surface of the face of the circle, instead of rising by the usual single screw; and in place of the inconvenient plan of having to reverse the hands so

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as to put the instrument into its box face uppermost, (which makes the getting of it out again without pulling at the reflector or some such delicate parts, difficult) by placing the legs not on the back but on the face, the instrument may be either put into its box, or down on the floor, or anywhere, face first, with the same hand which was moving it in the observation, with the divisions and the reflectors protected from all accidents, and the whole instrument ready at any time on a moment's notice (for the telescope never need be taken off, with its improved fixing), to take advantage of an instantaneous opportunity of observation.

So much for the use of the reflecting instrument at sea: as used on land, the following difficulties were found, and are generally recognised:—

1st. The impossibility of measuring in the mercury either sun or star when within, say 20° of the zenith, from the reflecting instrument not taking in so large an angle; and again, when within, say 10° of the horizon, from the foreshortening of the reflecting surface.

2d. The difficulty of seeing the referring point all night, viz. the reflected image of the star, when black glass is employed; and the trouble with wind when employing mercury, as well as with other causes producing vibration; and the great weight and liability to loss in long journeys through difficult and uncivilised countries.

All these difficulties seemed to be met by making the reflecting surface of speculum metal, levelled by a spirit-level; and when the reflected object could not be seen, attaching to the metal a collimating telescope, whose optical axis was parallel with the previously levelled surface, and was defined at the focus end by a horizontal slit, illuminated by a lamp at night, so as completely to remove all difficulty of seeing the referring object, and allowing of almost the whole object-glass being brought to bear on the star.

Difficulty having been found by the students in keeping sight of an object reflected from the artificial horizon, the latter was generally placed on a stand so as to bring it near the eye, and make it thereby offer a large angular space, which was pretty sure not to be exceeded by the shaking of the hand or involuntary movement of the head of an unpractised observer; but it was found requisite, not only to make the stand firm, but to improve the steadiness of the levelling screws, which was done by making them parts of a fixed frame, with the reflector moveable on them, and capable of being fastened in any position between opposite nuts.

A sextant with all the improvements (except the opposite readings), a full-sized model of a circle, and one of the reflecting horizon, were shown; but Prof. Smyth did not mean to claim any part of them as his own invention; for, without making any special inquiries as to how far he might have been preceded by any one else, he believed that he had only brought to bear on this subject individual improvements long and well known in other departments of the science: but as they had never, he thought, been so com-

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pletely united before, and as such a reunion might enable observations often to be obtained when now they are given up, he hoped that the communication might not be uninteresting to some of the numerous working members of the Society.

Bond's Ring of Saturn. Extract of a Letter from Mr. Hartnup.

"On the 15th September we had here one of those superb nights with which we are so seldom favoured. I never before saw *Saturn* so beautifully defined. The main division in the bright ring was steadily seen in every part, except where the ring was hid by the belt of the planet.

"Bond's ring could not be overlooked for an instant. I examined it carefully with powers from 170 to 1133, with all of which it was seen, but most distinctly with 404 and 606. The new ring is much broader than represented by Prof. Bond and Mr. Dawes when first discovered. It occupies full half, or from half to two-thirds of the space between the inner bright ring and the ball of the planet. It has a mottled appearance, is most distinct near its junction with the inner bright ring, and fades away as it approaches the ball of the planet."

M. C. Rümker has forwarded transits of the moon and moon-culminating stars over the meridian of Hamburg, for the following days:—

1850.

Jan. 20
21
Feb. 22
April 18
19
22
May 19
20
21

May 22
23
June 17
19
20
22
July 18
21
22

Aug. 18
19
20
Sept. 12
15
16
Oct. 13
Nov. 12

1851.

Jan. 11
14
15
Feb. 7
10
11

Feb. 13
23
Mar. 10
14
May 10
12

June 6
8
10
11
July 11

which are deposited in the archives for the use of those who may want corresponding observations.

On August 16, M. Hencke of Driesen observed a star in *Aquila*, of the 9th mag., which he had hitherto not seen in that place, and which, therefore, was probably a new planet or a variable star. The position for 1800 is,

R.A. $20^{h}\ 5^{m}\ 18^{s}$ N. Dec. $8^{\circ}\ 30'$

As Dr. Petersen found the star in the same place on August 19, it is probably a variable star.